Acephate 3.0.1

REPORT

ON

ACEPHATE

AND

METHAMIDOPHOS

3.0.1

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PREPARED FOR

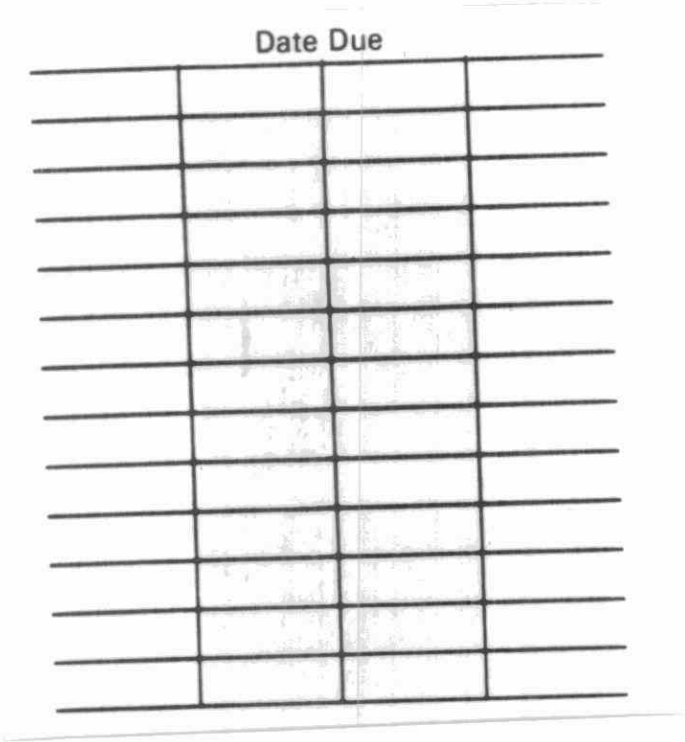
THE MINISTRY OF THE ENVIRONMENT

BY

THE PESTICIDES ADVISORY COMMITTEE

JANUARY, 1983

Ontario
Ministry of the Environment
Hon. Keith C. Norton, Q.C., Minister
Gérard J. M. Raymond Deputy Minister



THE

ONTARIO PESTICIDES ADVISORY COMMITTEE

ACEPHATE

AND

METHAMIDOPHOS

1982

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ONTARIO PESTICIDES ADVISORY COMMITTEE

RECOMMENDATIONS ON ACEPHATE AND METHAMIDOPHOS

The following recommendations are made by the Committee for acephate and methamidophos:

Acephate:

1. Until acephate has been removed from the IBT list, no new uses for the product be considered. The registrations for use on tobacco, horticulture uses and forestry be maintained, provided stress is placed on the need for the use of safety equipment.

2. Acephate be reviewed again in 1983, after the rat reproduction replacement study results have been received.

Methamidophos:

1. Methamidophos remain in Schedule 5, and special care be taken when handling or applying it.

2. No extension of the uses of methamidophos be permitted until IBT replacement studies have been completed.

3. Where possible, safer compounds should be found to replace methamidophos for use on potatoes and cole crops.

4. Methamidophos should be used only as a last alternative, and should not be applied by aircraft to agricultural crops unless there is no alternate efficacious pesticide available. The application of methamidophos from the air continue to be under a permit system.

SUMMARY

ACEPHATE:

1) Acephate still remains on the IBT list, and the requested replacement studies in Ontario will likely not be completed until early 1983. While it does have a tobacco registration and horticultural uses, it appears that its major immediate use will be in forestry. It has a registration for the control of cutworms, hornworms and aphids on tobacco, and further uses, if such are desired, will not be considered until acephate is cleared of IBT requirements.

2) Acephate, an organophosphate insecticide, has a relatively low toxicity. Dermal toxicity is low, and only slight skin irritation has been reported by in-plant workers. No skin sensitization has been reported. ORTHENE 75 S (acephate) is a mild eye irritant.

3) The half-life period for acephate on plants is relatively short, being reported at approximately 6 to 7 days under conditions of testing.

4) It is picked up rapidly by plants following soil drenches, or the application of the granular formulation.

5) Acephate is broken down rapidly in water. It is more persistent in pond water than in creeks or streams.

6) Acephate will move readily in soil, but has little or no effect on soil organisms. Soil organisms assist in the degradation of acephate in the soil.

7) Acephate is not bioaccumulated. Under operational spraying at normal spruce budworm suppression rates, only very minor and short term effects on stream fishes and invertebrates were noted.

8) Aerial application of acephate of 0.57 kg/ai/ha caused no mortality of birds, but in most birds and animals exposed, there was a suppression of brain cholinesterase.

9) No OSHA exposure standard or threshold limit value (TLV) has been established for acephate.

10) Acephate is only slowly absorbed through the skin. While dust formulation may be irritating to the respiratory tract, acephate is not acutely toxic by inhalation, but further information is needed on inhalation effects. The mouse, rat and quail study, using an aerosol concentration of 2.2 mg/l acephate resulted in 3 of 8 mice dying after 5 hour exposure. While no rats died after the 5 hours, 3 of 6 quail died after 100 minutes of exposure.

11) There was some indication of mitotic crossing over, gene conversion and reverse mutation in Saccharomyces cerevisiae D7 when exposed to acephate. It has also been shown to be positive as a point mutagen and caused primary DNA damage in the form of enhanced mitotic recombination. It was negative in the mouse dominant lethal tests giving no significant evidence of mutagenicity.

In vitro tests showed acephate to be mutagenic in Salmonella typhemurium, TA 100, Saccharomyces cerivisae D3 and UDS assays.

12) No teratogenicity or embryotoxicity was found when fed to rats. Some reproductive disturbances occurred in the F 2a generation in mice following the original feeding of 100 ppm of acephate in the diet.

METHAMIDOPHOS:

1) This product is sold as "Monitor" in Canada, and "Tamaron" in Europe. It is a Schedule 5 compound in Ontario. It is registered for the control of insects on cole crops and potatoes. It still remains on the IBT list, and it will likely be 1983 before all the IBT requirements are met.

2) Methamidophos is toxic, and, for this reason, it is in Schedule 5 in Ontario. The toxicity of the compound by any route, (acute, dermal, inhalation, etc.) would keep it in Schedule 5.

3) Methamidophos has only a very short impact on soil micro-organisms and, therefore, can be applied to soil.

4) Methamidophos may have an adverse effect on the physiology of fish, causing a permanently dropped lower jaw, if exposed to non-lethal concentrations.

5) Methamidophos is toxic to birds if they are exposed to sprays. Three of 6 quail died as the result of exposure to an aerosol concentration of 0.65 mg/l of methamidophos for 100 minutes.

6) The half-life of methamidophos in plant tissue is 8 to 9 days. While a withdrawal period of 7 days exists for lettuce and endive, it was found that it may take up to 14 to 21 days before the tolerance level of 1 mg/kg is reached.

7) Methamidophos has a longer residual life than acephate.

8) A chronic exposure study, using 20 pregnant rabbits exposed throughout pregnancy to methamidophos, indicated a significant reduction in litter size and in fetal birth weight. In the pregnant rabbits exposed, 10% of the mothers, as well as 9% of their fetuses showed pathologic changes in the liver, in the form of zonal necrosis, associated fatty changes, and lymphocytic infiltration.

ACEPHATE

USES

Acephate is registered on a temporary basis for use in Canada on tobacco, and appears in Schedule 2. It is used for the control of cutworms, hornworms and aphids, and has a three day withdrawal period. The temporary registration will be extended for the '982 year. The formulation is a 75% W.P.

Acephate, (Orthene Forest Spray Concentrate 97%) had temporary registration for 1981, and is in Schedule 2 for Ontario. It was cancelled for a period in the spring, and then re-issued later in June, 1981. It did receive temporary registration for 1982. The product was used in some areas for spruce budworm control in Maine in 1982.

Acephate, (Orthene Insect Spray E.C. 15.6%) has a temporary registration, and is in Schedule 3 in Ontario. It is used for general insect control on garden roses, flowers, ornamentals, shrubs and trees.

Acephate, (Orthene Tree and Ornamental Spray 75%) is also registered, and is in Schedule 2 in Ontario. This product has full registration for insect control on outdoor flowers, ornamentals, shrubs, trees and roses.

The total volume being used in Ontario is difficult to arrive at. None was used in the forestry spraying in 1981, but some was used in 1982. Very little was used for ornamental use. The major use, which was substantial, was for tobacco.

ACEPHATE

CHEMISTRY

Trademark Name: ORTHENE

Common Name: acephate

Chemical Name: O, S-Dimethyl acetylphosphoramidothioate

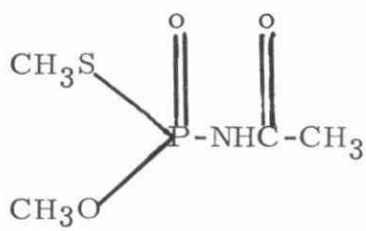
Other Designations: ORTHO 12420, ORTRAN

Patent Number: (pending)

Empirical Formula: $C_4H_{10}NO_3PS$

Molecular Weight: 183.16

Chemical Structure:



Molecular Composition: Percent by Weight

Carbon (C)	26.23%
Hydrogen (H)	5.50
Nitrogen (N)	7.65
Oxygen (O)	26.21
Phosphorous (P)	16.91
Sulfur (S)	17.50
	100.00%

Technical Composition: Acephate ..... 97.0% min.

Inerts ..... 3.0% max.

Physical Properties (97% Purity):

Appearance:	White solid
Odor:	Strong pungent odor (mercaptan type)
Melting point:	75-80°C
Density:	1.35
Volatility:	Low. Some minor products of degredation are volatile.

NOTE: ORTHENE Technical and formulations are hydroscopic. For this reason, ORTHENE products should be packaged in moistureproof containers and kept stored in a dry location until used.

Solubility

Solvent	Grams ORTHENE/100 ml Solution
Water	70
Acetic Acid	~65
Pyrrole	~62
Chloroform	~60
1,1,2,2-Tetrachloroethane	~60
Methyl Alcohol	~55
Dimethyl Sulfoxide	~55
Dimethylformamide	~54
Methylene Chloride	51
N-Methylpyrrolidone	~50
Acetonitrile	~44
Methyl Cellosolve	~40
Ethylene Glycol	~38
Ethyl Alcohol	34
Tetrahydrofurfuryl Alcohol	~32
Carbitol	~30
Cellosolve	~28
Methyl Carbitol	~26
Ethylene Dichloride	~25
Diacetone Alcohol	~23
Propylene Glycol Monomethyl Ether	~22
Propylene Glycol	~20
Iso-butyl Alcohol	~18
Amyl Acetate	~16
Acetone	15
n-Butyl Alcohol	~15
Isopropyl Alcohol	~15
Methyl Ethyl Ketone	~14
Tributyl Phosphate	<15
Triethyl Phosphate	<15
Amyl Alcohol	~12
Dipropylene Glycol Monomethyl Ether	10
Butyl Cellosolve	~10
Dioxane	~10
Dipropylene Glycol	~10
Tripropylene Glycol Monomethyl Ether	~10
Dimethyl Carbitol	<10
Carbitol Acetate	<10
Ethylene Glycol Diacetate	<10
Methyl Cellosolve Acetate	<10
Perchloroethylene	<10
n-Hexyl Alcohol	~ 9
n-Amyl Alcohol	~ 5
Isophorone	~ 5
Carbon Tetrachloride	< 5
Cyclohexanone	< 5
Glycerol Tracetate	< 5
Pine Oil	< 5
Methyl Isobutyl Ketone	~ 4
Ethyl Acetate	3.47
n-Octyl Alcohol	~ 3
Pentoxone	~ 3

Stability

Technical:

ACEPHATE Technical shows excellent stability when stored in suitable containers at 20-25°C.

After two years the loss in active content is less than 5%.

Formulations:

Soluble Powders:

ORTHENE 75 S contains a 7% relative overage to meet its label guarantee for more than two years when stored in suitable containers at 20-25°C.

ORTHENE 50 S and 25 S show stability comparable to that of ORTHENE 75 S. Although Ammonium Sulfate is the preferred diluent for these soluble powders, a number of other materials can be used, including diammonium phosphate, magnesium sulfate, potassium sulfate, potassium chloride, sodium sulfate and sugar.

Wettable Powders:

ACEPHATE can be formulated as a wettable powder using many common mineral diluents such as kaolin, talc, diatomites and calcium carbonate. With a 7% overage many of the wettable powder formulations will have two-year stability when properly packaged and stored at 20-25°C. Highly absorbent clays, such as attapulgites, generally cause severe degradation of ORTHENE and should be avoided. Porous vegetable products, such as wood dust, ground corn cobs, etc., should also be avoided.

Dusts:

Dusts can be prepared using the same diluents as described under wettable powders. Dusts with lower ACEPHATE content (<5%) are likely to be somewhat less stable than the wettable powders. ACEPHATE 10% dusts using calcium carbonate diluent shows excellent chemical stability.

Granules:

ACEPHATE granular products with active contents of 1-10% can be prepared on a variety of supports. Inert non-absorbent minerals and diatomites are preferred. Dolomite, silica, ammonium sulfate, diammonium phosphate, diatomites, pumice and other inorganic salts are suitable. Highly absorbent clay granules must be avoided. Organic carriers such as ground corn cobs should also be avoided. Stability data are limited. However, a log based on Dolomite should have at least one year stability at 20-25°C. ACEPHATE granular products with active contents of 1-50% can be prepared using Diatomite minerals. These newer ACEPHATE granules have good chemical stability if the ACEPHATE level is > 5% active.

Baits

ACEPHATE Baits (1 and 2%) can be prepared on sugar and have remained stable after several months of stability testing (tests still in progress).

Solutions:

ACEPHATE is quite soluble in water, but has only limited stability. A water solution containing 25-50% ORTHENE will lose about half of its activity in 2-3 months at 20-25°C. The effect of pH and temperature on the stability of ACEPHATE in dilute solution is shown by the following data:

Temperature, °C	20	40	20	20
pH	5-7	5-7	3	9
Half-Life, Days	50	20	65	16

ACEPHATE has better stability in alcohols and glycols than in water. The lower members, methyl alcohol, ethylene glycol and propylene glycol give solutions which may show a 10-20% loss after one year at 20-25°C. Under similar conditions, solutions based on the cellosolves and carbitols and isopropyl alcohol should show less than a 10% loss in ACEPHATE content. Similar stability is shown in tetrahydrofurfuryl alcohol.

ACEPHATE has good stability in chlorinated hydrocarbons such as methylene chloride, chloroform and tetrachloroethylene, and in pyrrole, dimethyl-formamide, N-methylpyrrolidone and acetonitrile. Losses of less than 10% would be expected after a year of storage at 20-25°C.

ACEPHATE is believed to be reasonably stable in esters, ketones and hydrocarbons, but the solubility is low, especially in hydrocarbons. The solubility of ACEPHATE in acetic acid is quite high, but no stability data are available.

Decontamination, Detoxification:

Note: Hypochlorite oxidants should not be used, since a chemical reaction may occur with ACEPHATE with the production of noxious gases. Hydrated lime and other alkaline materials attack ACEPHATE only very slowly at usual temperatures and therefore should not be used.

1. Spills:

Granules and Water Soluble Powders

a. Separate broken containers from the rest.

b. Carefully transfer remainder of contents of broken container into a drum or plastic bag.

c. If wind conditions might contribute to spread of the spill, dampen the dust lightly with water and cover the area with a plastic tarp or sheet.

d. Shovel the major portion of the spillage into a disposable container. Sweep up remaining material and dump sweepings into disposable container.

e. Flush surface with water, if feasible.

f. Remove sweepings for burial. The sweepings should be mixed thoroughly with earth and buried. The half-life of ACEPHATE in many soils is about two weeks.

Liquid Formulations

a) Remove all traces of the spill with an absorbent clay. A heavy granular absorbent is preferred. Work the absorbent into the spill with a stiff broom.

b) Shovel the sweepings into a disposable container, adding additional absorbent if necessary to obtain a dry sweep.

c) Flush surface with water, if feasible.

d) Remove sweepings for burial. The sweepings should b· mixed thoroughly with earth and buried. The half-life of ACEPHATE in many soils is about two weeks.

2. Container Decontamination

Steel Drums

a) Decontaminate as instructed in section 1. (above). The wash water is passed into a holding pond and kept there for one to two months, or until all ACEPHATE is degraded.

b) Make holes in drum so that it cannot be re-used.

c) Bury drum, or reduce to scrap for recycling purposes.

Cartons, Fiber Drums, Foil Packages

Do not burn. Bury in a non-crop area away from any possible water contamination, or dispose of in a sanitary land fill.

ACEPHATE

TOXICOLOGY

(Taken from technical data sheet
prepared by Chevron Chemical Company)

ACEPHATE insecticide is an organic phosphate pesticide of relatively low toxicity. It inhibits cholinesterase enzyme but to a much less pronounced degree than parathion, phosdrin or other more toxic organic phosphates. Cholinesterase studies in the rat showed that the effect of 900 mg/kg of body weight for ACEPHATE was not as severe as 15 mg/kg for parathion.

Acute Oral Toxicity:

Oral LD_{50}(99% Tech.)	Rat	Male: 945 mg/kg; Female: 866 mg/kg
Oral LD_{50}(75 S)	Rat	Male & Female: 1,494 mg/kg
Oral LD_{50}(89% Tech.)	Mouse	Male & Female: 361 mg/kg
Minimum Lethal Dose (MLD)	Dog	Male & Female: 681 mg/kg
Oral Antidote Study:	Rat	Atropine sulfate is an effective antidote for ACEPHATE insecticide; 2-PAM is less effective.

Acute Dermal Toxicity, Skin Irritation and Sensitization:

The dermal toxicity of ACEPHATE insecticide is low. It produced mild to moderate skin irritation and no sensitization reactions.

Dermal LD_{50}(99% Tech.)	Rabbit	Greater than 2,000 mg/kg body weight
	Bees	Acephate is extremely toxic to bees.

Dermal LD_{50}(75% S)	Rabbit	Greater than 10,500 mg/kg body weight
Skin Irritation (75% S)	Rabbit	No irritation observed on intact skin. Moderate irritation observed on abraded skin. Primary irritation score was 1.7 (maximum score of 8).
Skin Sensitization Potential	Rabbit	Neither the 90% Technical nor the 75 S formulation caused sensitization in the rabbit.
Skin Sensitization Potential	Guinea Pig	ACEPHATE technical (90%) did not cause any sensitization reactions.
21-Day Subacute Dermal Toxicity:		Rabbits were exposed to dose levels of 75% S formulation for 5 days/week for 3 weeks. Cholinesterase depression occurred at all 3 levels tested (0.5, 1.0 and 2 g/kg).
Acute Eye Irritation:	(93% Tech. and 75 S)	Test material was instilled into the eyes of rabbits using standard test methods. Slight corneal opacity and iritis was observed in some test groups. Conjunctival irritation developed in all test groups. By 14 days, all eyes appeared normal. ORTHENE 75 S is classified as a mild eye irritant with irreversible reactions.

Acute Inhalation and Vapor Toxicity:

The vapor pressure of ACEPHATE technical is low. Animal inhalation studies indicate low order of toxicity.

Vapor Toxicity:	(89% Tech.)	Rats were exposed for 4 hours to vapors generated by passing air through the Technical material. There was no mortality and cholinesterase values were not significantly different from those of normal unexposed rats.
14-Day Inhalation Toxicity:	(75% S)	Rats were exposed to aqueous aerosol dilutions up to 4% for 1 hour/day, 5 days/week, for 2 weeks. There were no consistent signs of poisoning or mortality observed. Data for hematology, organ body weight ratios, RBC and plasma cholinesterase activity, urine analysis and gross pathology for the treatment groups were consistent with data for the control animals.
Neurotoxic Study:	(94.5%	A demyelination study was conducted in the chicken. ACEPHATE did not produce neurotoxic effects indicative of demyelination.
90-Day Feeding Study - Rat:	(89% Tech.)	Dietary levels up to 300 ppm revealed no abnormalities in weight gain, food consumption, survival, blood and urologic studies, gross and microscopic pathology or organ weights and and ratios.
90-Day Feeding Study - Dog:	(94.5% Tech.)	A feeding study in beagle dogs at dietary levels of 10, 30 or 100 ppm caused no significant abnormalities except cholinesterase depression. RBC cholinesterase was depressed at the 100 ppm level; plasma cholinesterase was not effected. Brain cholinesterase activity was depressed at 30 or 100 ppm levels.

Mutagenic Potential:

A dominant lethal gene study in mice did not cause any mutations that lead to early embryonic death.

Teratogenic Potential:

Teratogenic studies in rabbits and rats did not show any internal or external fetal abnormalities or effects in skeletal development.

Carcinogenic (Tumorigenic) Potential:

Eighteen-month dietary studies in mice and 24-month dietary studies in rats showed that ACEPHATE technical did not induce any carcinogenic responses in these two animal studies.

Three-Generation Reproduction Study:

Rats were fed diets containing 30, 100 or 300 ppm of ACEPHATE technical during three generations. There were no effects in adult survival, body weight gains, organ weights, or histopathological findings. 30 ppm of ACEPHATE in the diet had no effect on mating or fertility indices. The 30 ppm feeding level showed no effect on pup survival or litter size. Pup survival and litter were reduced at the higher feeding levels in the 2nd generation, but not in the 1st or 3rd generations. Weanling body weights of test and control groups were essentially the same throughout the investigation.

Histopathological examination of weanlings from the 300 ppm test group revealed no findings which could be attributed to ingestion of ACEPHATE technical.

2-Year Feeding Study - Rat: (89-93%)

Rats fed ACEPHATE technical at dietary levels of 30, 100 or 300 ppm showed no significant differences in the following parameters: survival; food consumption; hematology; blood chemistry;

urine analysis; organ weights and ratios; or histopathological findings.

A slight depression of body weights was observed at the 100 and 300 ppm levels. Plasma and RBC cholinesterase were slightly inhibited at the 100 and 300 ppm levels; brain cholinesterase was slightly depressed at the 30 ppm level and moderately depressed at the 100 and 300 ppm levels.

Chronic Toxicity:

2-Year Feeding Study - Dog: (89% Tech.)

Feeding of ACEPHATE at dietary levels of 10, 30 or 100 ppm showed no significant differences in body weight, food consumption, reactions, mortality, hematology, blood chemistry, urine analysis, gross pathology or histopathology.

RBC cholinesterase was depressed at the 100 ppm level. No other significant depressions in cholinesterase activity were noted.

NATURAL ENVIRONMENT

Plant Residues

Residues of acephate were determined on tobacco sprayed at the rate of 1.12 kg ai/ha. Sampling was carried out ten minutes after spraying and again after curing. While residues of acephate were high ten minutes after spraying, 99.6% of the acephate was lost through conve tional curing and 99.8% was removed by bulk curing. (Scheviak, L.A., et. al., 1980)

Two formulations of acephate, an emulsifiable concentrate (EC) and a soluble powder (SP) were applied at the rate of 0.56 and 1.12 kg/ai/ha. Leaf samples were collected before spraying the tobacco, ten minutes after application, and one, three, five and nine days after spraying. Samples analyzed for acephate and methamidophos ten minute samples showed acephate levels of 16.7 ppm 1.12 kg/ai/ha, respectivly from the EC and 20.0 ppm and 50.4 ppm on the bottom leaves respectively for the ED applications and 20.0 ppm and 58.2 ppm for the S.P. formulation. Residue levels were approximately 2.6 times greater on the middle leaves and 2.6 times greater at the top than those found in the middle. One day after application the SP residues had declined 47% while the EC residues from the 0.56 kg/ha rate showed no decline and those from the 1.12 kg rate declined 24%. During the remainder of the sampling the residues of both formulations was the same. The total residue of acephate plus methamidophos on the cured leaf averaged 0.20 ppm on the day 5 samples. Losses of total residues during curing averaged 97%. (Leidy, R.B. and T.J. Sheets. 1978).

Plant Residues (cont'd)

In 1976 the half-life of acephate and its hydrolysates, methamidophos in the rind of oranges, grapefruit, lemons and tangerines was 10.3 and 10.5 days respectively. In citrus pulp it was 15.0 days for acephate and 6.1 days for methamidophos based on 7-, 14-, and 21 day data. Acephate levels in the rind were less than 3.0 ppm 14 days after treatment and in citrus pulp they were less than 3.0 ppm throughout the experiment. Methamidophos residue levels averaged less than 0.25 ppm after 21 days. (Nigg, H.N. et.al. 1976).

Residues of acephate and its toxic metabolite methamidophos on dooryard citrus foliage were determined during and following the three applications of acephate sprayed by helicopter for the control of the citrus blackfly (Aleurocanthus uroglumi Ashby) in Pompano Beach, Florida. Trees were sampled twice monthly for five months beginning before the spraying and continuing on through the treatment period and beyond until the acephate residues decreased below the level of detection. Acephate and methamidophos levels as high as 302.5 ppm and 15.8 ppm respectively, were detected on leaves within one day of the first series of treatments. Of the 143 samples collected 114 contained measurable residues for both compounds. Methamidophos accounted for 19% of the total residue. Both compounds degraded rapidly and residues dropped below 1 ppm, four weeks after the third spraying. Average foliage half-life for acephate 8.93 days (S.D. = 2.52) and for methamidophos 8.40 days (S.D. - 2.55) (No rates of application given) (Fitzpatrick, G.E. and M.D. Bogan 1980).

Plant Residues (cont'd)

The disappearance of acephate, methamidophos and malathion from citrus foliage indicated that acephate remained much longer than malathion. Acephate was applied at three week intervals at 0.6 g/l by high pressure sprayer and at 2.4 g/l by mist blower. Malathion was applied at 1.5 g/l by high pressure sprayer. Acephate disappeared as rapidly as the methamidophos but neither as fast as malathion. The half-life of malathion was 5.2 days and for acephate 6.8 days when mist blower used and 12.6 days for the high pressure application. (Nigg, H.W., et. al. 1981)

Seven of fifty tomato farms surveyed by the U.S. FDA in California were found to have residues of acephate in the tomatoes at 1 ppm or higher. While it is against the California law FDA laws to use acephate on tomatoes, six of the farmers admitted to using acephate. (Anonymous, Drug Intell. Clin. Pharm. 14(1); 78; 1980).

Side Effects

The toxicity of acephate to both Phytoseinbus persimilis Anthias-Henriot, a predacious mite and Tetranchus urticae Koch, Acephate is much more toxic to P. persimilis than T. urticae regardless of method of application and significant toxicity occurred via good-chain effects. Soil drenches of acephate of 75, 150 and 300 ppm were more toxic by this route than foliar sprays. In some cases the soil drenches killed nearly all of the P. persimilis feeding on T. urticae 21 days after application of the drenches. This will limit

acephate's usefulness in an IPM program involving P. persimils. (Lindquist, R. K. and M. L. Wolgammott, 1981).

The LD_{50} of topically applied acephate toward 4th and 5th instar silkworm larvae was 26-41 mug/g. The acephate in mulberry leaves sprayed with 500 ppm acephate suspension decreased from 20.8 to 0.80 ppm during the first 20 days after treatment. Continuous feeding of the treated leaves for 15 days after treatment caused up to 100% mortality of the larvae.

Leaves fed from soil applied granular acephate at 0.25 g/m^2 containing 0.2-1.0 ppm acephate did not affect the larvae, but leaves from soil treated with granular acephate at 5 g/m^2 containing 2.3 to 3.2 ppm acephate caused 100% mortality of 3rd and 5th instar larvae. (Sayto, Y. and H. Sugiyama, 1981).

The disappearance rates of acephate and its hydrolysis product (methamidophos) on citrus foliage was determined. The spraying took place every three week period at the rate of 0.6 g/l by high pressure sprayer. The acephate disappeared rapidly, as did the methamidophos. The mist blower application disappeared in 6.8 days and 12.6 days for the high pressure application. Residues did not accumulate from treatment to treatment. (Nigg, H. W., et al. 1981).

Acephate was applied to cranberries by fixed wing and by ground sprayers (high pressure using high volumes) at the rate of 0.5, 0.75, 1.0 lbs. ai/ac. There was an average of 0.64 ppm active ingredient (acephate and methamidophos) after 21 days following the ground application, while it took 23 days to reach 0.63 ppm when 3.04 lbs. ai/ac was applied by aircraft. (Winnett, G. 1981).

Using $C_{,4}$ acephate it was found that it was rapidly absorbed by 3rd instar tobacco budworm larvae and by adult boll weevils. It was metabolized to small amounts of methamidophos and at least four other non-toxic compounds, by the budworm larvae, but was not metabolized by the boll weevil adults. (Bull, D. L., et al. 1980).

Acephate (Orthene 755) was applied to Douglas firs to control western spruce budworm (Choriatoneura occidentalis). Approximately 91% control was obtained and a significant degree of foliage protection was obtained. High levels of pesticide residues were found for the first ten days. A rapid drop off took place for the next five days and was not detectable after 35 days. (Richmond, C. E., et al. 1979).

Water: Decomposition

Acephate, when added to a small coastal stream to yield a concentration of 1,100 - 1,200 ppb. for five hours rapidly declined upon completion of the treatment and was non-detectable in the water after 96 hours. (Geen, G. H., et al. 1981).

Acephate between pH 4.0 and 6.0 resisted any change in water despite temperature changes. At pH of 8.2 acephate hydrolysis was greatly influenced by rising temperatures. While only small amounts of methamidophos were detected between pH 4.0 and 6.0, quantitative amounts were found between pH 6.9 and 8.2. In pond water, acephate is more persistant than in creek water. It is likely that microbial action in the bottom of the pond into which 20% of the acephate moved in two days whereas it took nine days for 20% of the acephate to be removed by creek sediments. (Sayto, S.Y., et al. 1981).

Soil

Acephate leached readily through sand, fine sandy loam, clay and muck indicating that it would move readily in soil. (Bull, D.L. and T.N. Shaver, 1980).

Acephate exerted, in general, a stimulating effect on all soil microflora tested, such as: actinomycetes, fungi, yeasts and cellulose decomposers. While there was a temporary reduction in the nitrifying bacteria there was a greater population than that of the control after the 8th week after application. (Ramadan, E.M. and Z.H. Zidan, 1977).

Aspengillus and penicillium both grew well in malt extract containing 6400 ppm of tamaron. These soil fungi will degrade acephate to methamidophos. (Tamaron). (Zidan, Z.H. and E.M. Ramadan, 1977).

Fish and Aquatic Invertebrates

The physiological mechanisms of acephate toxicity to fish were studied by implanting buccal cathetors, dosal aorta cannulas and electrocardiogram electrodes in rainbow trout before exposure to 2,000 mg/l of acephate. Cholinesterase activities were determined in erthrocytes, serum, brain, gill, heart and skeletal muscle. The LC_{50} values at 8°C (cold stress), 15°C, and 22°C (heat stress) were determined for acephate and fenitrothion. The LC_{50} values for acephate were 600 to 1,000 times higher than those of fentrothion. Acephate toxicity was not affected by temperature. Heart rate was decreased and ventilation rate and buccal amplitude were increased upon exposure to acephate. Cholinesterase activity was inhibited in erthrocytes, gill, heart and serum after three hours exposure to acephate. This illustrates the importance of cardiovascular and respiratory systems which are important sites of action for organophosphate toxicity to fish. (Duangsawasdi, M., et al. 1979).

In testing the toxicity of acephate to cutthroat trout (Salmo clarki) there was no difference between the technical or formulated acephate. LC_{50} 100,000 mug/l. In the same study, stoneflies (pteronarcella ba dia) were more sensitive to acephate that were amphipods (Gammarus pseudolimnaeus). The LC_{50} for acephate (dependent upon pH) pH 6.5 and 8.5 was 25,000 mug/l for amphipods but 6,400 and 21,200 mug/l for stoneflies.

Two factors, potency of brain acetylcholinesterase (ACh E) inhibition and bio-transformation by liver homogenate, were investigated to understand the temperature -dependent toxicity of fenitrothion in rainbow trout (S. gairdner) and the 600 - 1000 fold differences in concentrations between fenitrothion and acephate required to produce death in these trout. Concentrations required to produce 50% inhibition of brain AChE were similar for acephate and fenitrothion (present as fenitrooxon) the oxidative desulfuration metabolite of fentithrothion was approximately five times more toxic. Incubation with liver homogenate demonstrated that a more potent brain AChE inhibitor was produced from acephate but not from fenitrothion. Hepatic biotransformation of fenitrothion to fenitrooxon does not explain previous observations of fenitrothion temperature dependency and differences in concentrations producing death. (Klaverkamp, J.F. and B. R. Hobden.)

Acephate was not accumulated in tadpoles to such levels that they were lethal when consumed in a single meal by ducks. No excessive concentrating encountered. (Hall, R.J., and E. Kolbe. 1980).

Following an operational spraying for the suppression of spruce budworm with acephate there were only very minor effects of short duration on stream fishes and invertebrates. Both salmon and trout were present in the streams. (Rabeni, C.F. and J. G. Stanley. 1979).

Brook trout taken from two streams in a sprayed area treated with 560 g/ha of acephate showed a marked increase in the consumption of the terestial anthropods Coleoptera and Aranlae. It was suggested that the spray

had put stress on arboreal spiders, causing some to fall from overhanging branches into the streams, where they were eaten by the fish. (Hydorn, S. B., et al. 1979).

Acephate was added to Hidden Creek, a tributary of the Fraser River, to simulate the effect of an aerial spray program. Yearling rainbow trout were placed in screen cages 24 hours before the acephate treatment. Orthene 75S was applied for five hours at a calculated rate of 1,000 ppb. The chemical was rapidly taken up by fish, sediment, insect nymphs, and insect larvae. No fish or insect mortality was noted even though the more toxic methamidophos was found in both groups. Acephate and methamidophos residues in animals and sediments declined to trace or non-detectable levels in 24 hours. Residues in water were non-detectable after 96 hours. The impact of acephate on the stream and its fauna was limited and localized. (Geen, G. H., et al. 1981).

Following the operational spraying for the control of spruce budworm using acephate, a survey of its effects on a stream was made. Water samples were collected at two sites at one hour, one day and two days following spraying and held for analysis. Fish were collected and brain cholinesterase was determined. The collecting of fish continued at regular intervals for six months following spraying. Stomach contents were analyzed and growth and condition factors were recorded. One hour after spraying acephate levels of 140 and 113 ppb were recorded at the two respective sites. By the second day, the levels were 41 and 9 ppb. There was a drop AChE activity in the brain of all fish tested within one to four days after spraying.

Following the four days there was an increase to higher or original levels. Immediately following spraying the fish diets were altered due to opportunistic feeding of terrestial insects. No difference in growth occurred. Population densities of benthic insects were not affected by spraying. While drift of insects increased immediately after spraying there was only local reduction damage which was short lived and minimal. (Rabeni, C.F. and J.G. Stanley, 1979).

Toxicity

Birds and Animals:

After an aerial applied application of 0.57 kg/ai/ha of acephate by helicopter in the Payette National Forest, Ca., birds and animals were collected between three and six hours after spraying and also on days 1, 3, 6, 25 and 26. On the day of spraying 11 of the 22 birds captured showed depressed brain cholinesterase (ChE) activities. One day later 14 of 26 birds expressed depressed ChE. At day 3, the ChE was depressed in 13 of 14 birds and at day 25, depressed ChE was found in 3 of 19 birds. Maximum depression was in the chipping sparrow on the sixth day when depression was 57%. Residue analysis for acephate and methamidophos in the brains of western tangers, dark-eyed juncos and Swainen's thrushes indicated only the western tanger collected on day 0, and one from day 3, contained detectable residues in the brain. Two Columbian ground squirrels collected on day 3 and one on day 6 had acephate residues in the brain. (Zinkl, J. G., et al., 1980).

The acute oral LD_{50} of acephate and methamidophos were carried out on dark-eyed juncos (Junco hymealis) and reported as 106 mg/kg and 8 mg/kg respectively for the two compounds. Brain ChE in birds that died

of acephate poisoning was depressed by 80% of that of the control birds. Birds that died of acute methamidophos poisoning had brain ChE depression or 60% of control. The birds killed by acephate had brain residues of acephate >2mg/kg and concentration of methamidophos usually >0.25 mg/kg. Only 8% of the birds killed with methamidophos had brain concentration >0.1 mg/kg. The five day feeding LD_{50} for acephate was found to be 1485 mg/kg. Birds in this five day study had lower ChE for both acephate and methamidophos that were found in the acute oral LD_{50} study.

Brain ChE activity returned to normal three days after the birds received a single sublethal dose of acephate. Investigations showed that most dark-eyed juncos exposed to forest applications of acephate would be about 20% of the LD_{50} dosage. (Zinkl, J.G., et al., 1981).

The effect on rabbits of chronic maternal exposure to tamaron throughout gestation period resulted in a significant reduction in the litter size and in the fetal birth weight. 10% of the mothers and 9% of their fetuses showed pathologic changes in the liver in the form of zonal necrosis, associated fatty changes, and lymphocytic infiltration. (El-Zalabani, I.M., et al., 1980).

General

Bees:

Acephate was found to be very toxic to bees at doses 128 times lower than those suggested for crop spraying, and following contact, even 52 hours after spraying. Widescale application of acephate will be a hazard to honeybees. (Arzone, A., 1980).

When acephate was tested for oral and contact toxicity for honeybees it was found to be very toxic. (Kupetz, H., et al. 1979.

ENVIRONMENTAL HEALTH

Introduction:

The toxicological studies involving acephate and methamidophos have not been extensively reported in the literature. This is very likely due to the fact that registration is fairly recent, and, in some cases, has not been completed for all possible uses.

Human Exposure:

Chevron has compiled reports on field experience from research workers applying acephate insecticide. Reports covering the exposure of 68 persons involved in field testing show no problems of intoxication or complaints resulting from this use. The only symptoms or complaints among personnel supervising and operating the production plant or formulating the product have been a few reports of minor skin rash or irritation. These reports are few in number and need further support.

Exposure Standard: No OSHA exposure standard or threshold limit value (TLV) has been established for acephate.

Physological and Health Effects: May cause skin irritation.

- Application into the eyes of rabbits produced moderate membrane irritation without corneal involvement

- Not expected to be irritating to the skin. Not expected to be acutely toxic by skin absorption. The acute dermal LD_{50} in rabbits >10 g/kg.

- Not expected to be acutely toxic by inhalation. Breathing the dust may be irritating to the respiratory tract. Four hour exposure to vapors resulted

in no toxicity in rats and cholinesterase values remained normal.

- Expected to have slight acute toxicity by ingestion. Acute oral LD_{50} for female rats 866 mg/kg, and for male rats 945 mg/kg.

Daily Allowable Intake: - established to be 0.018 mg/kg. (Huang, X., et al. 1980).

Inhalation:

Inhalation studies were carried out using acephate and methamidophos. Acephate is considered to be of low mammalian oral toxicity, and is considered to owe its insecticidal activity to de-acetylation in insects to the more toxic methamidophos (o, s-dimethyl phosphormadothioate). It was thought that perhaps some vertebrate species may convert acephate to methamidophos when they inhaled acephate. Groups of female mice, rats and quail were exposed to respirable aerosols of aqueons formulations of acephate and methamidophos. Doses were adjusted by varying the exposure time to a duration of up to five hours. Plasma cholinesterase depression was determined potentiometrically, and recuperation times were ascertained. Aerosol concentrations were about 0.65 mg/l for methamidophos, and about 2.2 mg/l for acephate. No rats died after five hours of inhalation exposure to the 2.2 mg/l level of acephate, but three of the eight mice dies after five hours exposure to the same concentration. Quail were more susceptible to acephate than mammals; three of the six died when exposed for 100 minutes. Based upon the aerosal concentrations, duration of exposure, minute volumes and information on whole body deposition, inhalation LD_{50} values of 18.7 mg/kg to mice and about 9.0 mg/kg to rats were estimated for methamidophos. Clinical signs were limited to mild tremors.

No evidence of conversion of acephate to methamidophos during atomization was detected. The toxicity of the two insecticides is not appreciably different via the inhalation route. The extent of plasma cholinesterase depression was compatable with mortality incidence. recuperation was slower with acephate. (Berteau, P.E. and R.E. Chiles. 1978).

Mutagenicity:

Mitotic crossing over, gene conversion and reverse mutation in Saccharomyces cerevisiae D7 resulted when exposed to acephate. It was reported that the D7 strain was better than the D3 strain for detecting mitotic recombination. (Riccio, E. et al. 1981).

Acephate has been shown to be positive as a point mutagen and caused primary DNA damage in the form of enhanced mitotic recombination. It was negative in the mouse dominant lethal tests giving no significant evidence of mutagenicity. (Waters, M. D., et al. 1980).

Acephate was found to be mutagenic in the Salmonella typhimurium in TA100, Saccharomyces cerivisiae D3, and UDS assays in in vitro tests. Simmon, V. F., 1980).

Teratogenicity and Embryotoxicity:

The LD_{50} of acephate for rats was found to be 825 mg/kg. Acute and subacute administration of acephate to rats inhibited the cholinesterase in blood and particularly in the brain. No teratogenicity or embryotoxicity was found for rats. The daily allowable ingestion rates for man was established at 0.018 mg/kg. (Huang, X. et al. 1980

Reproductive disturbances occurred in the 7 2 a generation in mice following the original feeding of acephate at a 100 ppm level. (Clegg, D. J. 1979).

GENERAL

Impurities:

A gas chromatograph method for the determination of acephate in the presence of the following impurities has been developed; o, o- dimethyl phosphoroamidothioate, o, o dimethyl-N-acetylphosphoroamidothioate, o-s-dimethylphosphoroamidothioate (methami 'ophos). (Bystricky, L., et al.)

Fate of Acephate:

A single foliar application of 14C-labeled acephate was absorbed rapidly by cotton leaves (>50% in 24 hours) and the unabsorbed residues were gone in 48 hours. The absorbed acephate was metabolized by the leaves to small amounts of methamidophos (approx. 9% of the dose) and its lesser amounts (<5% comb.) of 4 other products. Two of these products were identified as o, s-dimethyl-phosphorothioate and S-methylacetylphosphoramic-dothioate. The absorbed material was rapidly translocated throughout the plant including thefruit. Not sufficient in any one plant part to kill insect pests. (Bull, D. L. 1979).

Emergency and First Aid Procedures

Eyes:	Wash eyes with fresh water for at least 15 minutes. If irritation continues, see a doctor.
Skin:	Wash thoroughly with soap and water following any skin contact. Launder contaminated clothing.
Inhalation:	If respiratory inhalation or any signs or symptoms of problems occur, move person to fresh air. If any of these effects continue, see a doctor.
Ingestion:	If swallowed, give a large amount of water to drink, make person vomit, and call a doctor.
Fire:	Smoke from fires involving acephate may present unusual hazards. Avoid breathing smoke or mists. Avoid contact with fall-out and runoff. Minimize the amount of water used to fight fire. Do not enter enclosed area without full protective equipment including self-contained breathing equipment. Contain and isolate runoff and debris for proper disposal.

METHAMIDOPHOS

This product is sold under the name of Monitor in Canada, and Tamaron in Europe. It is sold by both Chemagro Chemical Co. and Ortho Chemical Co.

It is registered as a 4.8 lb. E.C. liquid. It is in Schedule 5 in Ontario.

It appears in Publication 363 for insect control in vegetable crops. Aphid control - cole crops; cabbage looper control - lettuce; and general insect control - potatoes.

It has a re-entry time of 48 hours. There is a tolerance of 1.0 ppm on broccoli, brussil sprouts, lettuce and peppers; and 0.5 ppm on cauliflower, cabbage, cucumbers, egg plant and tomatoes.

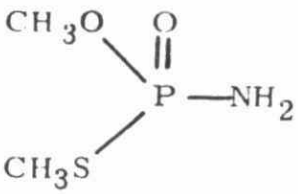
There is not a great deal being used in Ontario at this time, but indications are that its use may increase in 1982. It would appear that, at this time, there are substitutes available for control of the insects for which it is registered.

In the container disposal study, 89 empty Monitor 5 gallon pails were gathered at the Thedford Marsh site. (Miles, et al., 1981).

Methamidophos is much more persistent than is acephate, and has been reported to be much more toxic in nature.

The active ingredient methamidophos has been placed by FIFRA into the restricted classification which limits its use by or under the direct supervision of a certified applicator. (Fed. Registry Vol. 46, Bk. 3, 5696, 1981).

METHAMIDOPHOS

Trademark:	Monitor Tamaron
Common Name:	methamidophos
Chemical Name:	o, s-dimethyl phosphoramidothioate
Composition of Technical:	Actual ..... 97% Inerts 3%
Emperical Formula:	$C_2H_8NO_2PS$
Chemical Structure:	

Physical Properties:

Appearance:	Off-white crystalline solid
Odor:	Strong, pungent odor
Melting Point:	39-41° C
Solubility:	In water 9 g/100 ml at 20° C Soluble in alcohols, aliphatic chlorinated hydrocarbons but only slightly soluble in ether
Half-life:	120 hrs. at pH 9 and temp. 37° C 140 hrs. at pH 2 and temp. 40° C
Corrosive:	Corrosive to mild steel and copper
Formulations:	Available as a 4 lb/gal emulsifiable concentrate

Suggested Disposal:

Methamidophos is very susceptible to alkaline hydrolysis and this fact should be made use of as a safe method for disposal of the product. (Lande, S.S. 1978).

Manufacturing:

The insecticide methamidophos (o, s-dimethyl phosphoramido-thiolate) acylated under mild conditions with monocarboxylic acid or half esters of dicarboxylic acids with the acid of dicyclohexylearbodiimide. This method gives a better yield and purer products than acylation of the insecticide with carboxylic acid chlorides or anhydrides. (Look, M. 1980).

Toxicology:

75% Technical

Acute oral LD_{50}	-	Female rat	18.9 mg/kg
		Male rat	21 mg/kg
		Guinea pig	30-50 mg/kg
		Rabbit	10-30 mg/kg
		Hens	25 mg/kg
Acute Dermal	-	Rats	50-100 mg/kg

NATURAL ENVIRONMENT

Soil:

There was a 1 - 2 week decrease in the numbers of aerobic nitrogen fixers, but by the end of 4 weeks, the numbers had increased to a level higher than in the controls, thus Tamaron did not have any adverse effects when applied to soil. The increased number were found to be still present 2 weeks after the application. (Ramadan, E. M., and Z. H. Zidan. 1977).

Aspergillus grew well in a malt extract medium containing 6,400 ppm of Tamaron. Penicillium grew well in a medium containing 200 - 400 ppm of Tamaron. (Zidan, Z. H., and E. M. Ramadan. 1977).

Fish:

Fingerlings of common carp were exposed to methamidophos concentrations of 0.5, 1.0 and 1.5 mg/l of water for 6 weeks. Poisoned fish demonstrated permanently dropped lower jaws. Brain and liver A ChE and carboxylerase were inhibited at sublethal doses. Brain carboxylesterase was inhibited to a greater extent than was brain A ChE, possibly suggesting that the carboxylesterase afford protection to A ChE by competing with them for the organophosporus compounds. It was found that the same distinction was not found in the liver. (Chin, G. N., and K. I. Sudderuddin. 1979).

Birds:

The calculated oral LD_{50} of methamidophos to dark-eyed juncos (Juneo hyemalis) was 8 mg/kg. Birds that died of acute methamidophos poisoning had brain ChE depression of 60%. The residues in the brain had concentrations of 0.1 mg/kg. (Zinkl, J. G., et al, 1981).

Water:

In the hydrolysis of acephate, only trace amounts of methamidophos were found at pH levels between 4.0 and 6.0, but quantitative amounts were found between pH 6.9 and 8.2. The hydrolysis was not effected by the temperature changes. Methamidophos was found to be much more stable in all pH ranges than was acephate. (Szeta, S., et al. 1979).

The methamidophos converted from 1100 - 1200 ppb of acephate added to a coastal stream for 5 hours was found in fish, sediments, insect nymphs, and larvae up to 24 hours after treatment of water, and there, trace levels were found in the water until 96 hours had passed. (Geen, G.H., et al. 1981).

Inhalation: Mice, Rats and Quail

In an attempt to ascertain whether some vertebrate species may convert acephate to the more toxic compound methamidophos when they inhale acephate, groups of female mice, rats, and quail were exposed to respirable aerosols of aqueous formulations of acephate and methamidophos. Doses were adjusted by varying the exposure time to a duration of up to 5 hours. Plasma cholinesterase depression was determined potentiometrically and recuperation time was ascertained. The aerosol concentrations were about 0.65 mg/l for methamidophos. Based upon the aerosol concentrations, duration of exposure, minute volumes and information on whole body deposition and inhalation the LD_{50} values of 18.8 mg/kg to mice, and about 9.0mg/kg to rats were estimated for methamidophos. Quail were much more susceptible than mammals when 3 of 6 died after 100 min. exposure to acephate and methamidophos. There was little or no

difference in the toxicity of acephate or methamidophos via the inhalation route. The extent of plasma cholinesterase was compatible with mortality induced, recuperation was rapid with methamidophos but slow with acephate. (Berteau, P.E. and R.E. Chiles. 1978).

Plant Residues:

The average citrus foliar half-life for methamidophos was found to be 8.40 days (S.D. = 2.55) under field conditions at Pompano Beach, Florida. (Fitzpatrick, G.E. and M.D. Bogan. 1980).

Methamidophos was applied to Chinese cabbage, Cos lettuce, head lettuce and cauliflower growing on muck soil. The rate applied was 1.12 kg/ai/ha^{-1} in 1975, 76, 77, and in 1978 the same rate was applied to head lettuce. While the tolerance level for methamidophos is 1 mg/kg^{-1} and a withdrawal period of 7 days exists for lettuce and endive, it was found it took 14 to 21 days to drop this level. This would indicate a withdrawal time of 14 to 21 days is necessary. The Chinese cabbage and cauliflower residues found would indicate the need of a 14 to 21 day withdrawal if the 1 mg/kg tolerance level is to be met. (Braun, H.E., et al. 1980).

Pesticides and Toxic Chemical News, October, 1981, reported that the FDA carried out a survey of produce from Mexico entering the U.S.A., and found that methamidophos residues on strawberries were detected more than any other pesticide used on strawberries.

ENVIRONMENTAL HEALTH

Introduction:

Methamidophos is one of the compounds that is on the IBT list. At the present time some of the claims are temporary in nature and no new claims can be added until cleared from the IBT list, which will not be likely until 1983 at the earliest.

The data available at this time would indicate that methamidophos is much more toxic than acephate and, while it has a relatively short life, it does persist longer than acephate.

More toxicological data is required on this compound.

TOXICITY

Human:

In 1976 an epidemiologican and environmental disaster occurred when approximately 3,000 agricultural workers were adversely affected by a combination of Tamaron (methanidophos) and guthion (aginphos-methyl) used in the spraying of cotton. (Sallam, M. and E.H. El-Ghawaby, 1980).

Re-Entry Time:

Methamidophos was one of the pesticidal compounds included in a research project to ascertain the residues of pesticides following foliar application so as to assist in establishing a safe re-entry period to protect workers.

In 1975 methamidophos was applied to head lettuce with a knapsack sprayer. Samples were taken in 8-hour intervals from 0 to 48 hours. In 1977 methamidophos was applied to cauliflower at the rate of 1.1 $kg/ai/ha^{-1}$. The cauliflower was mature but was not tied, so that both foliage and curd were treated. Samples were taken at 0, 24 and 48 hours following application.

Residue work was carried out, making no attempt to distinguish between total residue and that portion which may be dislodged. Residues of methamidophos on lettuce declined rapidly during the first eight hours (from 54.7 mg/k^{-1} to 26.7 mg/kg^{-1}). The residues declined less rapidly after the eight hour period and were still present at 30% of the initial deposit. The residues on cauliflower, while less than found on lettuce, followed a similar pattern to that found on lettuce. A number of other

factors such as geographic location, climate, etc., must be considered in establishing re-entry time. Of major importance is the percentage of total dislodgeable residue which decreases with time, and the portion of the dislodgeable residue that is actually absorbed on contact, which also decreases with time after application. (McEwen, F. L., et al. 1980).

Toxicology

Mutagenicity:

Chronic maternal exposure to Tamaron (methamidophos) throughout gestation was studied using 20 pregnant rabbits. A significant reduction in the litter size and in the fetal birth weight was observed. In pregnant rabbits exposed, 10% of the mothers and 9% of their fetuses showed pathologic changes in the liver in the form of zonal necrosis, associated fatty changes and lymphocytic infiltration. (El-Zalabani, I. M., et al. 1980).

Cholinesterase:

The LD_{50} for methamidophos i.p. was reported to be 15 mg/kg which is similar to parathion and paraoxon. Some differences in structure and reported failure of cholinesterase inhibition to take place in insects promoted the study of its reaction with mammalian cholinesterase to determine if the current method of treatment for the poisoning requires modification. Atropine (10 mg/kg) or pralidoxime (60 mg/kg) afforded sufficient protection against lethality from methamidophos (LD_{50} 60 ± 0.4 and 52 ± 4.9 mg/kg respectively.) Partial spontaneous recovery of inhibited cholinesterase activity was observed. A single dose of pralidoxime given simultaneously with methamidophos did not hasten the recovery of the cholinesterase. (Robinson, C. P., et al. 1980).

In 1979 an experiment utilizing male rats was started to show the inhibition of cholinesterase (ChE) by the insecticide methamidophos and its spontaneous and pralidoxime-induced reactivation. In order to determine rate constants various rat tissues were used (plasma, erythocytes and brain). These were isolated and exposed to methamidophos and then assayed for ChE activity. The rate constant for inhibiting rat plasma ChE was $1.57 \pm 0.03 \times 10^3$/M/min., for rat erythocytes ChE was $8.86 \pm 1.10 \times 10^3$/M/min., and for rat brain 6.58×10^3M/min. Rat brain and plasma ChE is spontaneously reactivated in vitro with approximately 50%. (Robinson, C.P., et al., 1980).

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